Annual Report 1985

Forest Products and Forest Industrial Development Research Program

Alberta
ENERGY AND NATURAL RESOURCES

Alberta
ECONOMIC DEVELOPMENT

ALBERTA RESEARCH COUNCIL

To:
Mr. F.W. McDougall
Deputy Minister of Energy and Natural Resources
Edmonton

Mr. D.J. Gendall
Deputy Minister of Economic Development
Edmonton

Dr. R.W. Stewart
President, Alberta Research Council
Edmonton

Sirs:

I have the honor to present the Annual Report relating to the Forest Products and Forest Industrial Development Research Program for the fiscal year ending March 31, 1985.

Respectfully submitted,

C.B. Smith
Chairman, Management Committee
Forest Products and
Forest Industrial Development
Research Program

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Highlights

The fiscal year 1984/85 marked the third year of operation for the Forest Products and Forest Industrial Development Research Program. The program comprised two elements - strategic studies and forest products research and development.

This annual report covers the period April 1, 1984 to March 31, 1985 and contains details of each project carried out during the year.

Highlights:

- A strategy was proposed for the utilization of hardwood resources in northern Alberta.
- An evaluation of the Tigney Technology steam explosion process revealed that it has technical and economic merit.
- A decision was made to build a 1.5 cu. ft. gun to demonstrate and optimize the Tigney Technology process.
- Equipment was developed to accelerate aging of panel products.
- A press with the capacity to apply a force of 500 tons across 2 ft. x 4 ft. plattens has been designed and constructed.
- The Alberta Research Council Forest Products Testing Laboratory received accreditation, in principle, from the Standards Council of Canada.
- A patent application was made for the process and apparatus for the manufacture of corrugated waferboard.

Background

Alberta's forest and forest products primary industries are an important economic force, accounting for more than 11 percent of manufacturing-sector employment in the province and generating roughly $724 million worth of products in 1982. The province's forest resources, however, in terms of both softwood (spruce and pine) and hardwood (aspen and balsam poplar) are far from fully developed. As a result, only about one-third of Alberta's annual allowable cut is presently used.

It has been estimated that in addition to the 7 million cubic metres of softwood currently harvested every year in Alberta, another 20 million cubic metres of softwood and hardwood could be cut annually on a sustained yield basis. This potential harvest could dramatically increase manufacturing opportunities in such fields as structural wood products, pulp and paper, energy, wood-based industrial chemicals and feed products.

One of the major reasons for underutilization of Alberta forests has been the presence of vast stands of poplar, a hardwood considered unmerchantable because of its unsuitability for conventional forest products such as lumber, veneer and pulp and paper. In recent years, however, the Alberta government has become increasingly aware of the potential of this virtually untapped resource. Accordingly, planning began for a comprehensive program aimed at not only solving the problem of poplar utilization, but also enchancing development of Alberta's forests as a whole.

Two components were envisioned: a number of strategic studies designed to determine the quality of the forest resource in Alberta and to investigate market opportunities; and an ongoing forest products research and development program focused primarily on the hardwood resource.

Impetus for the program came from the three provincial agencies primarily concerned with the development of Alberta's forest industry: Alberta Energy and Natural Resources, responsible for the utilization, development, management and protection of Alberta's forest resources; Alberta Economic Development which oversees product and market development and encourages industrial development in Alberta; the Alberta Research Council, which conducts the forest products research program and acts as technical consultant to both Energy and Natural Resources and Economic Development.

As a result of recommendations by an advisory committee representing the three government agencies, industry and the University of Alberta, a permanent Forest Products and Forest Industrial Development Research Program was created on April 1, 1982. The Alberta Research Council was chosen to house the new program because of its mandate, structure and rapport with industry, and a forest products research and development program was already incorporated into the Alberta Research Council's Long Range Plan.

During 1982-83 a modest laboratory for testing and forest products development was established. Additional testing capability was provided in 1983-84 and again in 1984-85. The laboratory is now housed in the new Alberta Research Council building in south Edmonton. The laboratory was accredited as a testing agency by Canada Mortgage and Housing Corporation in 1983 and the Standards Council of Canada in 1985.

Management Committee

The Ministers of Energy and Natural Resources and Economic Development along with the President of the Alberta Research Council agreed upon the following terms for the operation of the Management Committee.

- The Committee will consist of the Assistant Deputy Minister (or his designate) from each department and the Vice-President Industrial and Engineering Research Division (or his designate) from the Alberta Research Council.
- The Assistant Deputy Minister of Energy & Natural Resources will act as Chairman of the Management Committee.
- Based on proposals made by or acceptable to the Committee, the Committee will agree in principle on the broad scope of the long-term Forest Products and Forest Industrial Development Research Program to be carried out.

The Committee will meet periodically to review progress and to agree upon the projects that will make up the research and strategic studies program for the one year period immediately ahead. A review of the previous year's progress will also be carried out.

Once agreement has been reached on the list of projects for the one-year period immediately ahead, arrangements will be made by Energy & Natural Resources to transfer to the Alberta Research Council and Economic Development the funds necessary for carrying out their respective projects for the year.

The Committee shall be responsible for coordinating all government funded research pertaining to forest products and forest industrial development.

On March 31, 1985 the Management Committee members were:

Alberta Energy & Natural Resources
Mr. J.A. Brennan
Assistant Deputy Minister
Alberta Forest Service

Alberta Economic Development
Mr. K.H.G. Broadfoot
Assistant Deputy Minister
Development and Trade

Alberta Research Council
Dr. D.L. Mitchell
Vice-President
Industrial and Engineering Research Division

Non-voting members on the Management Committee were:

Mr. B.W. Karaim (Secretary)
Forest Products Advisor
Alberta Forest Service

Mr. R.G. Anderson
Director
Forest Industries Section
Alberta Economic Development

Dr. L. Bach
Manager
Forest Products Program
Alberta Research Council

Mr. A.A. Roehl
Head
Materials and Testing Department
Alberta Research Council

Program objectives and guidelines

The Forest Products and Forest Industrial Development Research Program has three basic objectives:

- to increase and improve the commercial utilization of Alberta's forest resources;
- to promote and support research into the development and efficient use of Alberta's existing and potential forest resources;
- to encourage the development of Alberta-based scientific and technical expertise in the field of forest products.

Proposals for specific research projects are reviewed and assessed within the context of the following guidelines.

Eligible research projects shall include those relating to resource and industrial development assessment; forest products; production; marketing; transportation; and utilization of Alberta's forest resources.

Preference will be given to applied or mission-oriented research projects, although some consideration will be given to funding of appropriate basic research projects.

Consideration will be given, under certain circumstances, to proposals for construction of new or improved physical facilities for forest product-related research in Alberta.

The Alberta forest products industry will be encouraged to participate in the program, through submission of appropriate research proposals and through its advice as requested.

Most approved projects will be carried out under a legal agreement between Alberta Energy and Natural Resources, Alberta Economic Development or the Alberta Research Council and the researchers, specifying the terms and conditions under which the research funds will be expended, and under which the technology will be disclosed, owned, and licensed.

Those interested in further information about this report or any of the project summaries featured on the following pages are invited to address their requests to:

The Chairman
Forest Products and Forest Industrial Development
Research Program
Alberta Energy & Natural Resources
10th Floor, South Petroleum Plaza
9915 - 108 Street
Edmonton, Alberta
T5K 2C9

Strategic studies projects

Project title:
Technical-economic evaluation of the Tigney Technology steam explosion process.

Objective:
To evaluate the Tigney Technology process and the market prospects for the products derived via this technology.

Project responsibility:
Alberta Forest Service

Investigators:
Battelle Columbus Laboratories

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:

- Steam explosion technology consists of three major segments: steam explosion proper that manufactures "gun fibre"; separation of gun fibre into its constituent cellulose, lignin, and hemicellulose sugars; and applications for steam explosion products.

  The state of the art in steam explosion proper is such that commercial sized guns can be designed but routine development work is required to adapt the steam explosion technology to specific end use requirements and to specific incoming raw materials.

  The state of the art in gun fiber separation is at the laboratory stage with few or no data on separation systems that would be used in commercial scale facilities. The state of the art in applications for steam explosion products generally is at the laboratory and pre-pilot plant stage. Although the state of the art is not highly advanced, the next steps in the development can be rather clearly perceived and feasibility appears to be high; based on theory and experience.
- Technically, steam explosion under the conditions described in Canadian Patent 1,096,374 represents a set of conditions that differs in a demonstrable way from conventional steaming technology. The gun fiber that is initially formed has constituents (cellulosic microfibrils and lignin globules) that are not present when wood is processed other ways. Furthermore, wood that is processed under other conditions does not give the clean-cut cellulose and lignin products obtained in the Tigney Technology.
- Based on a capital investment of $60 million for a 500 tpd facility to manufacture bleached chemical cellulose, lignin, and a hemicellulose syrup from wood that is purchased for $40 per ton, the before tax profit is expected to exceed 30 percent. This favorable profit position is contingent on development of markets for all three major products.
- A new Finnish process for making regenerated cellulose that requires cellulose with the characteristics of steam explosion cellulose (but which other types of cellulose do not have) provides a potential market for more than 3 million tons per year at approximately $800 per ton.
- The major markets for lignin appear to be in phenolic resins employed as wood adhesives, urethane polymers for foams and engineering polymer applications, encapsulating agents, and carbon black substitutes.
- The hemicellulose sugars have prospects in animal feed or possibly furfural production.
- Gun fiber could be employed as a substrate on which to grow edible mushrooms. Gun fiber can also be used as an animal feed ingredient, either alone or as pellets in combination with the hemicellulose and urea.

Implications:
Development of a much cheaper, smaller, cleaner and more efficient system of separating lignin from cellulose and hemicellulose than that which presently exists. Also, this technology is more suited to processing hardwoods primarily aspen than softwoods. Alberta has huge resources of undeveloped aspen and the economic benefits of applying the steam explosion technology throughout Alberta would be enormous.

Conclusions:

- Battelle concludes that the Tigney steam explosion technology has merit in terms of technical feasibility and economic promise. A sharply-defined, comprehensive research and development program is needed to fulfill its potential.
- An integrated research and development phase in which a pilot plant is constructed and used to prepare samples for evaluation, to optimize operating conditions, and to obtain data required for a large scale plant design is the next step. The pilot plant activities must be meshed with an integrated program involving market research and venture analysis so that the information needed to make the go/no-go decision regarding construction of a full-scale facility can be made. It must be launched with sufficient momentum to carry through to a definitive go/no-go decision on construction of a full-scale facility.

Further work:
To develop a sharply-defined, comprehensive research and development program.

Project title:
R&D planning for Phase I of the development of the Tigney Technology steam explosion process.

Objective:
To develop a work plan describing what should be done in the first stage of development of the Tigney Technology steam explosion process.

Project responsibility:
Alberta Forest Service

Investigators:
Battelle Columbus Laboratories

Source of funding:
Canada/Alberta Forest Resource Development Agreement

Results as of March 31, 1985:
The following plan was developed.

- Tigney should build a facility at Alberta Research Council's Clover Bar site that is equipped to operate the steam explosion technology, using a 1.5 cubic foot gun.
- Tigney should demonstrate a smoothly functioning steam explosion system.
- Tigney should prepare and characterize samples of gun fiber.
- Tigney should explore both caustic extraction and ethanol partitioning methods to separate gun fiber into its constituent products.
- Tigney should characterize the separated gun fiber products.
- Tigney should screen cellulose product for bleachability.
- Tigney should screen lignin products for end-use applications, especially in the rubber industry.
- Tigney should screen gun fiber for applications in reinforced polymers.
- Tigney should prepare a comprehensive report with specific development and commercialization plans for Phase II.

Implications:
Acceptance of the proposed work plan would require a funding commitment of almost $1 million.

Conclusion:
The degree of economic promise and technical readiness needs to be assessed by construction of a small pilot unit and operation of that unit to obtain samples from authentic Albertan poplar feedstocks. Furthermore, the samples need to be analysed and characterized by modern methods to determine their composition and the degree to which their composition may vary during normal processing operations. The screening of authentic samples for major end-use applications; especially for the manufacture of chemical cellulose and lignin based adhesives also is needed before a major program can be mounted in Alberta.

Further work:
Once Phase I has been completed, data generated should be incorporated into a model for estimating scale up costs and revenues and Phase II modified accordingly. If profit picture still very positive proceed with Phase II.

Project title:
Aspen treatment for dimensional stabilization.

Objective:
To develop and optimize an analytical procedure for determining concentration and distribution of polymers in treated wood; to co-relate the treating method with polymer distribution in the wood using the above analytical procedure; to investigate a cheaper and more effective treatment by combining varying amounts of reactive polymer with cross-linking polymer for the purpose of identifying an ideal or optimum combination.

Project responsibility:
Alberta Forest Service

Investigators:
Aditi Research Ltd.

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
- An analytical procedure for quantitative analysis of thermoplastic acrylic polymers in treated wood was developed. The procedure consists of sectioning of treated wood, grinding the sample followed by methanol extraction. The extract is dried and the residue determined gravimetrically.
- An analytical procedure for quantitative analysis of the self cross-linking polymer in wood was also developed. The procedure consists of dissolving a section of the wood in 95% sulfuric acid to remove the cellulose, followed by soaking in chromic acid to remove the lignin and other extractives. The residual polymer is washed, dried and weighed.
- A qualitative colour test to detect the presence of an acrylic polymer was adapted for use on wood treated with such a polymer solution. The test has been found most useful in determining the extent of penetration into aspen.
- A procedure for quantitative analysis of glyoxal resin in wood, consisting of nitrogen determination was obtained from Mississippi State Wood Products Department.
- To determine the degree of stabilization of treated wood a unique combination of equipment was set up to measure the rate of swelling of treated and untreated wood and the apparatus calibrated. Results obtained to date show a 30-60% reduction in swelling after a 24 hour water soak.

Implications:
Development of a much cheaper and more effective wood treatment process would increase the utilization of lower grade species such as aspen.

Conclusions:
For commercial operations which do not have dry kilns, the thermoplastic acrylic polymers provide the best stabilization results. Solutions of different concentration, i.e.: 2, 4 or 8% deposit about the same amount of polymer per unit weight of wood within the wood.

For commercial operations which do have dry kilns, a mixture of 80% glyoxal resin and 20% self cross-linking acrylic provide the best stabilization results. However, in order to obtain these results the final kiln temperature must reach 80-90°C.

Further work:
Optimization of processes using the various polymers has yet to be completed. Also studies need to be carried out on the wood preservation potential of polymers and various additives.

Project title:
Utilization of hardwoods in northern Alberta.

Objectives:
To prepare from recent literature a concise, readable description of the hardwood resource, as well as industry and government research activities to develop it. In particular to summarize the potential opportunities, benefits and problems associated with the development of hardwoods. To examine the constraints to the development of the resource, including physical, technical and economic considerations. This analysis should lead to a series of recommendations or a potential strategy for the future development of the hardwood resource in northern Alberta.

Project responsibility:
Alberta Forest Service

Investigators:
Woodbridge, Reed and Associates Ltd.

Source of funding:
Northern Alberta Development Council (NADC) 50% and the Forest Products and Forest Industrial Development Research Program 50%.

Results as of March 31, 1985:
- Young stands in some areas of Slave Lake and Whitecourt are believed to offer the best development opportunities. High volumes of aspen, generally with good age class distributions, have been identified in parts of the Peace River, Grande Prairie, Footner and Lac La Biche forests. They represent a potentially significant opportunity for hardwood manufacturing development.
- The most promising development options (1985-1990) are: aspen/softwood CTMP, lightweight coated paper (LWC), (bleached aspen kraft market pulp), and specialty lumber. Those which have longer term potential (1990-2000) are: uncoated groundwood papers, and waferboard/OSB.
- One of the keys to successful economic expansion of the underutilized portions of the forest resources of northern Alberta is the development of an adequate transportation infrastructure.
- A good business climate is conducive to new investment: a poor one obviously is not. There are two aspects of business climate - the existing image and, information. Alberta scores very well in producing information and studies related to aspen potential. However, Alberta scores less favourably in the identification and active promotion of specific investment options.
- Northern Alberta's external economics in forest products are limited. At present they include items such as softwood lumber, waferboard and market pulp. For some of the new product opportunities identified above, the limited external economies which exist in northern Alberta are not necessarily an unsolvable problem providing that at least some of the factors (i.e. key trained operating personnel and management) can be brought into the region by an established producer of such grades from another region, or where such skills can be obtained through joint-venture, or affiliate, arrangements involving the producer and paper maker/paper user.

Implications:
Areas which offer the best investment climate usually are the first to attract new investment. Canada's recent history has not been good in this respect and unless this changes, much of the potential for forest products production in northern Alberta may not be realized.

Conclusions:
- The NADC should direct its future policies for forest products development towards the active promotion of the aspen-based products short listed above.
- The NADC should coordinate its active promotion campaign with initiatives being undertaken by provincial government departments and prepare promotional package for distribution.
- Hardwood AAC's should be recalculated at the earliest opportunity, taking into account age class distribution, decay-age trends, and softwood harvest schedules. For those areas having good potential there is a need to clarify their availability for hardwood utilization. Utilization standards need to be defined as well as reforestation requirements.
- A program of active marketing should be developed in consultation with or carried out by the provincial government.

Further work:
To hold a seminar in Whitecourt to discuss the results and recommendations of this study.

Forest products research and development projects

Project title:
Establishment of a forest products testing and development laboratory at the Alberta Research Council.

Objective:
To provide capability in Alberta to perform standard, physical, mechanical and chemical testing of wood and forest products manufactured in Alberta.

Project responsibility:
Alberta Research Council

Investigators:
Alberta Research Council staff

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
In 1984/85 the capability of the Alberta Research Council's forest products testing and development laboratory was expanded further.

- Standards Council of Canada accreditation was granted, in principle, to the laboratory.
- A test method was developed to measure shear and tension strengths of glue joints.
- A press with the capability to exert a force of 500 tons across 2ft. x 4ft. plattens was designed and constructed by B.S.L. Machine Ltd. of Edmonton in cooperation with Alberta Research Council staff.
- Uniformly distributed loading equipment for panel products was designed and constructed by Alberta Research Council staff.
- A blender and former were designed by Alberta Research Council staff and fabricated by Scientific Machinery and Welding Ltd. of Edmonton.
- A computer aided data processing system was developed for general purpose work.
- Installation of creep loading test equipment for structural panel products was completed.
- Equipment was developed to accelerate aging of panel products.
- Further minor equipment was purchased and installed.
- The laboratory was moved to the new Alberta Research Council facilities at Mill Woods, Edmonton.

Implications:
The Alberta Research Council is now able to assist the Alberta forest products industry with most standard tests pertaining to wood-based building materials. With accreditation from both CMHC and SCC, ARC achieved a national testing laboratory status.

Conclusion:
Alberta now has a recognized, accredited, forest products testing laboratory ready to serve the Alberta industry, as well as other parts of Canada.

Further work:
Continue to build up the forest products testing and product development capability in the following areas: 1) reconstituted wood products, particularly panels, 2) on-line non-destructive testing of panels, but with increasing emphasis to be placed on developmental activities.

Project title:
Conceptual engineering design studies for an on-line machine stress rating (MSR) system for panel products.

Objectives:
- To develop a conceptual engineering design for an on-line automated MSR system to measure stiffness of full-size panels. The study is to be performed in sufficient detail to permit cost estimates of the final design.
- To produce layout drawings of the placement of the MSR system in manufacturing plants when used for 1) panel grading or 2) quality control.
- To acquire a database useful in the estimation of on-line MSR potential at individual Alberta panelboard plants.

Project responsibility:
Alberta Research Council

Investigators:
Columbia Engineering International Ltd., and the Alberta Research Council

Silvacom Ltd., and the Alberta Research Council

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
During 1982/83 the Alberta Research Council acquired prototype equipment for the non-destructive stiffness testing of panel products and in 1983/84 conducted successful evaluations of the equipment in the laboratory and in panelboard plants. Further a report was prepared by a consulting engineering company, covering:
- conceptual mechanical design and equipment pricing for dynamic on-line testing of panel products;
- conceptual electrical design and equipment pricing for on-line MSR system for panel products; and
- conceptual locations of stress rating machines in industrial scale panelboard plants;

During 1984/85 as a continuation of this prior work:
- field trials were conducted at all Alberta panelboard plants manufacturing structural panels;
- draft reports were issued to each company concerning MSR potential for the companies' panel products; and
- a workshop on MSR was held in Edmonton with the participation of all five Alberta panelboard manufacturers.

Implications:
The studies completed in 1984/85 are adequate for the purpose of obtaining quotations from companies that have the capability to prepare the final design and construct prototype on-line MSR equipment.

Conclusion:
The technical and preliminary cost data for the construction of an on-line MSR system for panels are now available.

Further work:
Obtain firm quotations for the cost of constructing an on-line MSR prototype system for panel products once a decision has been made to proceed.

Obtain industry support for construction of an on-line MSR prototype system and install in a plant on a demonstration basis.

Project title:
Engineering feasibility concept for the manufacture of corrugated waferboard.

Objectives:
- To perform engineering feasibility studies for manufacturing corrugated waferboard.
- To design and construct a set of press plattens for laboratory scale manufacture of 2′ × 4′ corrugated panels.

Project responsibility:
Alberta Research Council

Investigators:
The Alberta Research Council and B.S.L. Machine Ltd.

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
- A concept for the manufacture of corrugated waferboard has been developed.
- A set of press plattens has been designed and manufactured.
- Patent application for process and apparatus for the manufacture of a corrugated waferboard panel has been filed.

Implications:
According to well-established mechanical engineering theories, panel stiffness and load carrying capacity can be greatly improved by using a corrugated rather than a flat profile without using more material. If proven in practice, such a result could lead to substantial improvements in the performance of waferboards and if adopted could place Alberta manufacturers in a leadership position within the industry.

Conclusion:
The performance of corrugated waferboard has been shown to be theoretically superior to that of regular waferboard. The production of corrugated waferboards appears to be technically feasible. A set of plattens of unique design has been manufactured. These plattens can be used to test the theoretical predictions in the laboratory and to determine the physical properties of corrugated panels.

Further work:
- Place and commission a panel press and manufacture laboratory panels with the new plattens.
- Test experimental laboratory panels (corrugated waferboards) for physical properties and compare with theoretical predictions and characteristic properties of equivalent flat panel.

Project title:
Chemical characterization of steam-exploded aspen wood.

Objective:
To chemically characterize the steam-exploded aspen wood and study the effect of the process on the wood components.

Project responsibility:
Alberta Research Council

Investigators:
Alberta Research Council staff

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
Two reports were written. The summary of the results were:

- After the steam-explosion process, some of the wood components became soluble
  - 25% in water (mainly sugar from hemicellulose fraction)
  - 10-20% in alcohol (mainly lignin).
- The average molecular weight of isolated lignins was 1000 - 1500.
- Those lignins extracted with alcohol were thermoplastic.

Implications:
The steam-explosion process may be an ideal way to utilize Alberta aspen as chemical feedstock for a number of products.

Conclusion:
By exploding wood under an optimum set of conditions, it is possible to render it suitable for partitioning into three industrially valuable components (cellulose, hemicellulose and lignin).

Further work:
Obtain more consistent and predictable steam exploded wood samples in order to determine the effect of process parameters on the properties of the products.

Also identify simple but effective partitioning methods and to investigate most valuable end use applications for respective partitioned components.

Project title:
A method to rate the strength and stiffness of structural panel products manufactured in Alberta.

Objective:
To develop a database useful in the evaluation of machine stiffness/strength rating methods for Alberta made structural panel products.

Project responsibility:
Alberta Research Council

Investigators:
Alberta Research Council staff

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
- 8000 4′ × 8′ structural panels were tested for stiffness in five Alberta mills. The results were related to further laboratory tests of the strength properties. The variation of stiffness and strength is of a magnitude that causes concern.
- An individual technical report was submitted to each mill, showing the variation in stiffness and strength of the company's panel products.
- A series of meetings were held with the mills to discuss the technical aspect of the reports.

Implications:
The Alberta structural panel manufacturers now have technical data at hand that permit calculation of the potential volume of machine stiffness/stress rated panels (if a change from the present grading system is made).

80% of the Alberta panel manufacturers have expressed interest in the development of an automated grading system.

Conclusion:
Stiffness and strength data are now available. These data, together with marketing information provided by the mills can be used to analyze the economic benefit of new structural panel grades to Alberta mills.

Further work:
The database obtained is to be updated as the manufacturing practices in the mills change.

Project title:
Time-dependent properties of panel products.

Objectives:
- To develop a suitable method to test the time-dependent properties in panel products under sustained loading.
- To screen the time-dependent behavior of panel products manufactured in Alberta.

Project responsibility:
Alberta Research Council and University of Alberta

Investigators:
Alberta Research Council and University of Alberta

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
- Test jigs were developed for both low and high stress sustained loading of 300 mm and 1200 mm wide panel samples.
- Preliminary testing was conducted in duration of load experiments lasting 100 days. The time-dependent behavior observed clearly points to the importance of duration of load experiments. The results obtained appear poorly related to the short term test that the panel manufacturers and building authorities routinely apply to assure adequate panel performance in service.
- Cooperation with the U.S. Forest Products Laboratory in Madison, Wisconsin is under discussion.

Implications:
The Federal Canadian and U.S. Governments are considering a large cooperative study on the time-dependent strength of panel products. The Province of Alberta has been invited to participate. Based upon the results of ARC studies to date it is highly likely that existing test procedures for sustained loading of panels will be modified. If this is so it will be essential for Alberta manufacturers to know how their panels are likely to perform under the new test procedures in sufficient time for continued compliance to be assured.

Conclusion:
The results of the work undertaken to date point to probable changes in test procedures which will be applied to Alberta panel products. A knowledge of the performance of such products and successful modification methods is essential if Alberta manufacturers are to maintain product compliance in the long term.

Further work:
- The University of Alberta has planned basic studies to test the applicability of non-linear viscoelastic theories to various Alberta-made panel products in engineered structures, such as light industrial buildings.
- The Alberta Research Council and the University of Alberta are ready to expand cooperation on studies related to time-dependent flexure of Alberta panel products when adequate funding and space are made available.

Project title:
Product assurance testing of OSB, waferboard and plywood.

Objective:
To provide third party quality assurance testing services as requested by the Alberta panelboard industry.

Project responsibility:
Industrial clients

Investigators:
Alberta Research Council staff

Source of funding:
Industrial Clients and the Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:

- Third party mechanical and physical assurance testing according to test specifications by Canadian Standards Association (CSA), American Society For Testing and Materials (ASTM), Canadian Mortgage and Housing Corporation (CMHC), American Plywood Association (APA) and others, was carried out in the Forest Products Testing Laboratory at the Alberta Research Council in Mill Woods.
- Eight (8) technical reports on the test results were prepared and submitted to the clients.

Implications:
The availability of third party assurance testing in Alberta can improve the competitive position of Alberta forest product manufacturers.

Conclusion:
Confidential information relevant to the competitive position of Alberta products was supplied to Alberta manufacturers.

Further work:
To continue to provide these services to Alberta industry on a cost of recovery basis.

Project title:
Mechanical and physical testing of new glued products.

Objective:
To assist Alberta industry with mechanical testing of new structural components made from Alberta wood.

Project responsibility:
Alberta Research Council

Investigators:
Alberta Research Council, Western Archrib Ltd., Canadian Forest Industries Ltd., and Jager Industries Ltd.

Source of funding:
Industrial clients and the Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
- A start has been made in the development of new types of glued wood components using Alberta wood.
- Using test methods partially devised by the Alberta Research Council, useful results have been obtained concerning new applications for Alberta panel products in glued structural components.

Implications:
Through analysis of test results, Alberta companies may be able to identify new markets for glued products made from Alberta wood.

Conclusions:
- New business opportunities have been identified for several Alberta companies.
- It was demonstrated that Alberta Power Ltd.'s requirements for crossarms can be adequately met with Alberta made glued timber.
- It was shown that it is technically feasible to make glued aspen beams with strength properties equal to that of solid clear aspen wood.

Further work:
- Projects utilizing Alberta wood in glued timber are being considered.
- Projects related to structural components utilizing Alberta panel products are in the planning stage.

Project title:
Technical investigations pertaining to possible upgrading of a forest products manufacturing plant.

Objectives:
- To conduct a technical audit of the present manufacturing operation at the plant.
- To suggest plant improvement possibilities.

Project responsibility:
Alberta Research Council staff

Investigators:
Alberta Research Council staff

Source of funding:
Forest Products and Forest Industrial Development Research Program and a private company

Results as of March 31, 1985:
A technical report was prepared outlining several options for improvement in the manufacturing plant's operations.

Implications:
If successfully implemented, the recommendations of the report could contribute to the continued commercial operation of the plant.

Conclusion:
As the result of the work the plant is now in the process of assessing options for upgrading its manufacturing capability.

Further work:
No further work planned at this point.

Project title:
Testing of reinforcement of timbers in historic buildings.

Objective:
To test the adequacy of various proposed methods for restoration of the strength of wood components in historic buildings.

Project responsibility:
The Alberta Research Council

Investigators:
Alberta Research Council and Mr. H. Webersdorfer (private consultant)

Source of funding:
Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
Selected samples were tested at the Alberta Research Council Forest Products Laboratory to the satisfaction of Alberta Culture.

Implications:
The results obtained were useful in the upgrading of historical buildings in Alberta.

Conclusion:
A method to reinforce old timber components with epoxy materials appears feasible to use in the restoration of historic buildings in Alberta.

Further work:
No further work has been planned.

Project title:
Testing of round log crossarms from the Slave Lake - Fort McMurray transmission line.

Objective:
To test the residual strength in selected round crossarms.

Project responsibility:
Alberta Research Council

Investigators:
Alberta Research Council and University of Alberta

Source of funding:
Alberta Power Ltd. and Forest Products and Forest Industrial Development Research Program

Results as of March 31, 1985:
Exploratory testing was conducted at the Alberta Research Council Forest Products Laboratory and at the University of Alberta Structural Laboratory. A technical report was submitted to the client.

Implications:
Circuit outages on the Slave Lake - Fort McMurray transmission line cost approximately $40,000/hour. The data collected will assist the company in decisions pertaining to upgrading of the line to reduce the possibility of outages caused by crossarm failures.

Conclusion:
The data collected show varying degrees of deterioration of strength in the crossarms tested due to a combination of weather, stress concentrations and duration of load effects. Although adequate strength is believed to be present in most of the installed crossarms, non-destructive testing is suggested for all questionable crossarms remaining on the line.

Further work:
Further work will be carried out at the option of Alberta Power Ltd.

List of published reports

1979 The preliminary evaluation of the market for Alberta kraft pulp, by Kearney Management Consultants Ltd. Free on request.

1979 Energy and chemicals from wood, by SNC Tottrup and Associates. Free on request.

1980 A directory of primary wood-using industries in Alberta, 1979 by Canadian Forest Service and Alberta Forest Service. Free on request.

1982 Evaluation of the hardwood resource in the O'Chiese block, by Pedology Consultants and D.A. Westworth and Associates. Free on request.

1982 Analysis of poplar based panelboard development program options for Alberta, by Carroll-Hatch (International) Ltd. Available for the price of $10.

1982 Poplar chemical process development and demonstration facility, by W.L. Wardrop & Associates Ltd. Available for the price of $15.

1982 Annotated bibliography of the relevant literature on the utilization and properties of western Canadian poplars, by Forintek Canada Corp. Free on request.

1983 Forest research needs for the management of aspen and poplar in Alberta, by W.R. Dempster and Associates Ltd. Free on request.

1983 A study of Alberta's secondary forest products manufacturing industry, by Hallmark Engineering Ltd. and Woodbridge, Reed and Associates Ltd. Free on request.

1983 Market assessment for poplar products, by Carroll-Hatch (International) Ltd. Free on request.

1983 Competitiveness of the Albertan vs. the U.S. southeastern forest industry by Jaakko Poyry International Organization. Free on request.

1983 Newsprint from Alberta woods, by CIP Research Ltd. Free on request.

1983 Bleached CTMP from decayed and stained aspen logs, by Woodbridge, Reed and Associates, and Econotech Services Ltd. Free on request.

1983 To assess new drying methods for aspen lumber, by Forintek Canada Corp. Free on request.

1983 To demonstrate ways of upgrading Alberta sawmills, by Forintek Canada Corp. Free on request.

1983 Chemical characterization of aspen wood - clear, stained and decayed trees, by N. Cyr, Alberta Research Council. Free on request.

1984 CTMP of aspen in various states of decay, by Sunds Defibrator AB. Free on request.

1984 Feasibility of producing mechanically laminated wood beams from aspen and softwood lumber, by Morrison - Hershfield Ltd. Free on request.

1984 Effects of aspen bark as a filler in polymer composites, by D.J.F. Polymer Consulting Ltd. Free on request.

1985 Utilization of hardwoods in northern Alberta, by Woodbridge, Reed and Associates. Free on request.

Summary of expenditures

Pursuant to the terms of the five-year agreement with the Alberta Research Council, a sum of $548,000 was transferred from Alberta Energy and Natural Resources to the Alberta Research Council by March 31, 1985 in support of the forest products research and development program. The Alberta Research Council contributed a further $75,000 for a total 1984/85 annual forest products research and development program budget of $623,000. As of March 31, 1985 expenditures on approved projects were $685,000.

The forest industrial development part of the program received funding in the amount of $291,000. Expenditures on approved projects as of March 31, 1985 were $263,000.

The total allocated to both subprograms was $914,000 and total expenditures on approved projects as of March 31, 1985 were $886,000.